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Research Article

The Future in the Power Systems Shines With Small Residential Smart Photovoltaic On/Off Cells

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Abstract

The aging energy infrastructure come to and end. The fossil resources are, politically controlled.The climate change exigencies and his threat to the survival of humanity is real. The increase in domestic electricity consumption have forced the power industry to examine its health.Mankind is at the turning point of its energy future.The rise of renewable technologies can not be ignoring, and its the geographical distribution feature is a huge advantage.A sort of renewables, the photovoltaics, produces everywhere, for everyone.The future power systems will contain intelligent generators, intelligent store facilities and intelligent consumers with intelligent behaviors. Microgrid,a small energy system with locally interconnected generators, consumers and storage facilities, within physical limits,should be parts of large power system. The future does not belong to the microgrid but to the intelligent structure that minimaze the cost and boost the efficiency. Instead of micro, nano or picogrid the Intelligent Energy Cell, IEC, is the answer. IEC besides the today microgrid, contains anintelligent generator (inverter), which optimize the behavior of all component, generator its self, consumer, storage facilities and the exchange with the public grid.This IEC would be in the same time isolated and connected between another IEC's and the public grid. The future power energy system, the Intelligent Energy System, IES, would be as a tissue of IECs. The next step of development concerns the IES. Here all the major component has its own DNA. In such futurepower systems, all components communicate between them. A superviser task is reduced because every major component, every inelligent energy cell, every consumer would have its proper DNA and in a specific situation know what to do, as the human cells knows.

Keywords: Future, Intelligent energy cell, Intelligent energy system, DNA

Introduction

The concepts of Intelligent Energy Cell, IEC, and Intelligent Energy System, IES, like a tissue of IEC were introduced by [Căpățînă, 2013], as result of a holistic vision on the energy power systems. The former smart grid concept, was necessarily, but comes from a narrow or partially vision. Now, more than before the need for a new approach on power systems are obviously: the fossil resources are declined and politically controlled, the danger of climate change is finally perceived,the increase of energy consumption. Concentration of carbon dioxide in the atmospherehas rapidly increased. In year 1960, the concentration had risen to values up around 315 ppm and just half a century later the concentration was over 400 ppm(figure 1).What's even worse is that the phenomenon seems to be out of control, and we do not know what's going to happen.

We are contemporary with a phenomenon of rethinking the energy systems, some are aware of and others do not, even though they all participate in this rethinking.But this rethinking phenomenon is due to the following: 1)a huge technological advance in the field of computers, artificial intelligence and communications, 2)technological advance in the energy conversation, 3)energies produced from renewable sources are competitive, 4)the investment costs

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in renewable energies are also competitive. The advance în renewable energy it is a common fact and accepted every where. The IEA predicts spectacular growth of renewable energies all over the world. (Figure 2).

visible light. The unijunction structures have a potential proportional to the ratio defined as the open circuit voltage, Voc, divided by the optical bandgap, Eg, as on can see on figure 3, [Ossila, 2018]. Even without this promises potential, today the kWh produced by photovoltaic is

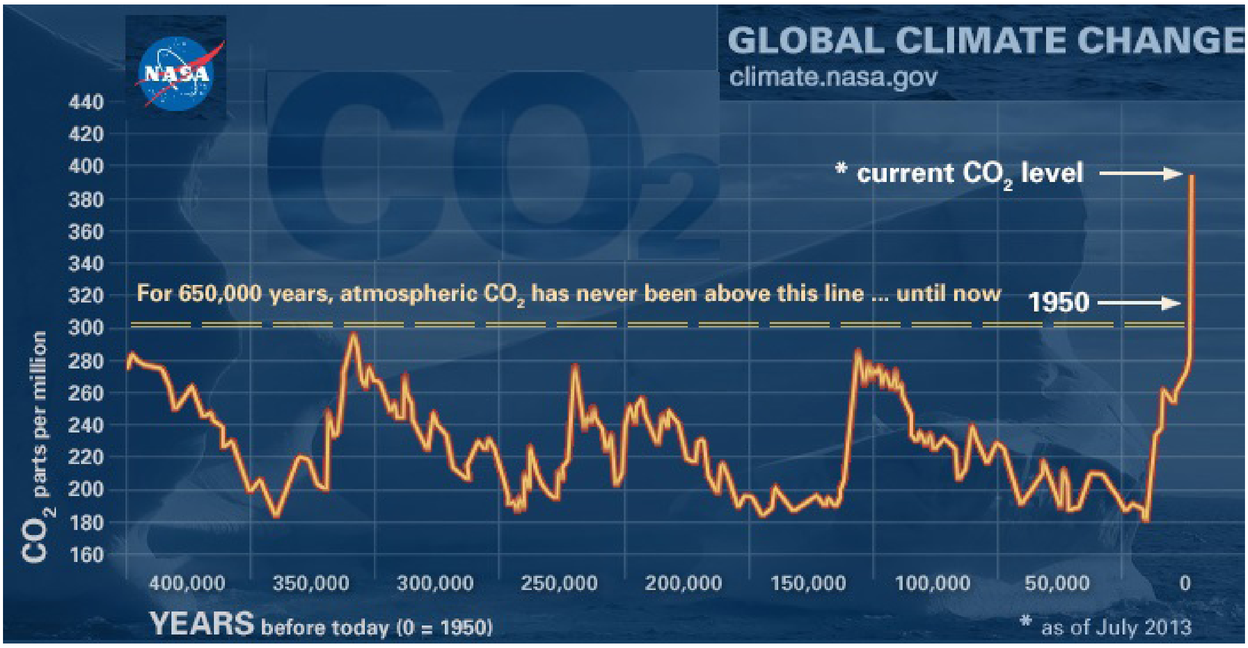

Figure 1.CO_2emissions over past 650.000 years [NASA Surface Meteorology and Sun]

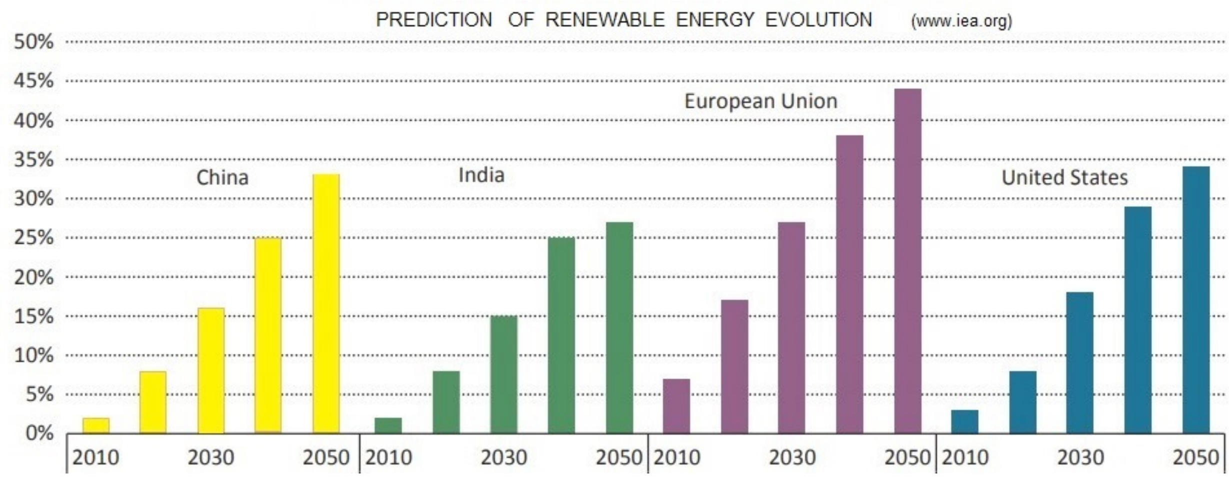

Figure 2.International Energy Agency's forecasts over renewable energy till 2050

Photovoltaic and D.E.R.

Between wind and solar, the solar irradiation is far most predictable and as consequence more useful and easier to administer it. And this is not the only advantage of the solar resource toward the wind. The efficiency of conversion of wind power into electricity is near the maximum, there is no way to grow much. The same can not be said about the conversion of solar energy. Perovskite and perovkite structure technologiespromises to double the efficiency of photovoltaic panels.A perovskite structure is anything that has the generic form like Ca Ti O_3 and the same crystallographic structure. However, the perovskite layer promises to capitalize the infrared rays as well as the

one of the best on whole energy market as can been see on fig.4,[IRENA,2016].In Saudi Arabia for a 300MW photovoltaic project at the auction (Febr 2018) the levelised cost of energy, LCOE, were announced between 1.78-2.34cUSD/kWh. [REW, March 2018]. The IEA predictions will be overcome, and the argument is precisely the photovoltaic kwh price.

But the biggest advantage of solar energy to all others is its democratic appearance. The sun shines everywhere for everyone. So, at the same latitude. From this third advantage come out one of the future power system feature – the distributed feature. Distributed Energy Resources, DER,are, small-scale power generation sources located near

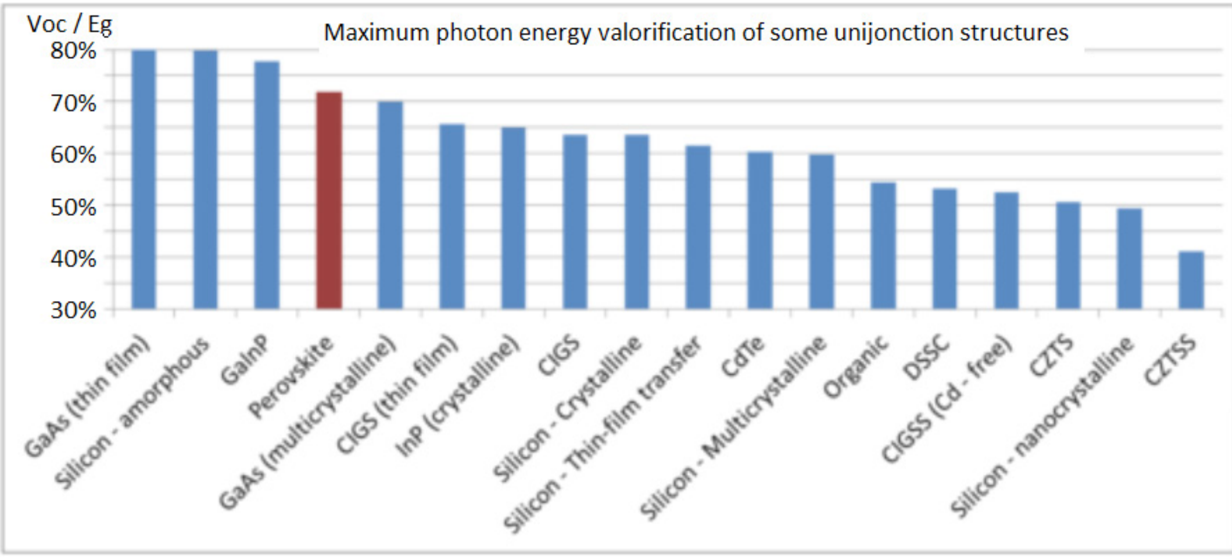

Figure 3.The maximum photon energy utilisation for common single junction solar cells material systems [Ossila, 2018]

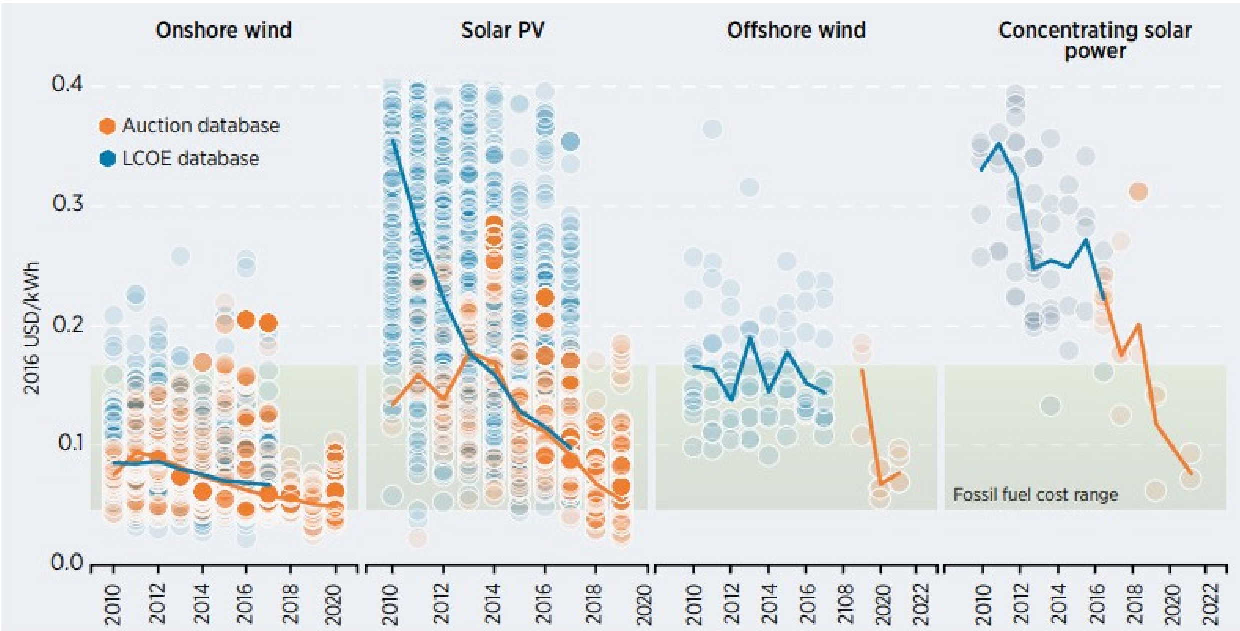

Figure 4.The levelized cost of kWh produced by onshore and off shore wind, PV and concetrating solar power based on IRENA database and ongoing auctions. [IRENA, 2016]

the end user assuring an alternative to the public grid. If we add incidences of electricity shortages, power quality problems, rolling blackouts, and electricity price spikes, then distributed energy generation is a big challenge for the large scale power systems.The very near future of energy that is seen is to be distributed and solar, near the existing one large energy systems.

The Place of Small Residential Photovoltaic

In [Căpățînă, 2018], on find it surprising that although in Romania there is on average a higher solar radiation by 26% than in Germany, the energy output per watt installed in Romania is only 9% higher than in Germany. Examining the causes, while the 1.3GW photovoltaic park in Romania is totally in large parks with medium voltage networkflow, in Germany 85% of the 44.45GW installed park runs directly in low voltage grid. The loss of efficiency in Romania towards Germany is explained by energy losses in power transformers and in transport lines.

There was a myth that large photovoltaics parks are producing energy at a lower price than the energy produced in small residențial cells. Slowly, researchers realize that in the judgement large scale photovoltaic parks efficiency must be consideredthe upload of energy in Medium Voltage lines (figure 5).

Dealing with renewables, it is a huge mistake to neglect the problem and the cost of transmission lines if it is the

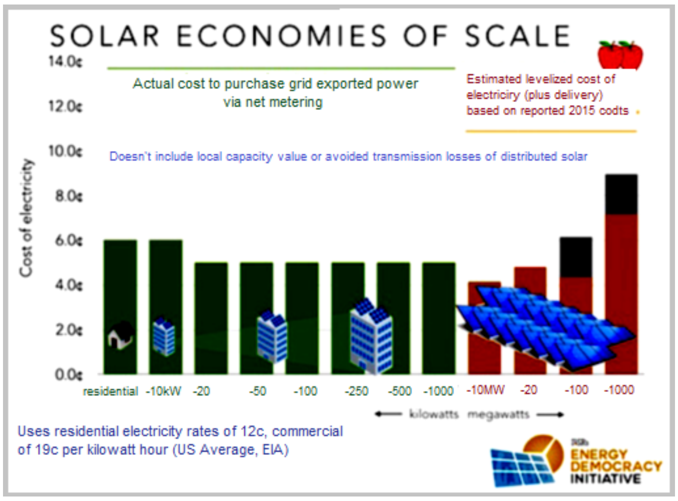

Figure 5.Reviewing LCOEs in large photovoltaic parks by counting expenses with energy uploading and transmission lines.[Farell, 2018]

case. In Germany, since 2012, the photovoltaic kWh is cheaper as the kWh from mix sources of public grid; in Romania is even cheaper.Today challenge to the obsolete energy systems based on fossils, for many seems to be the microgrid.But this issue is only a half step forward.

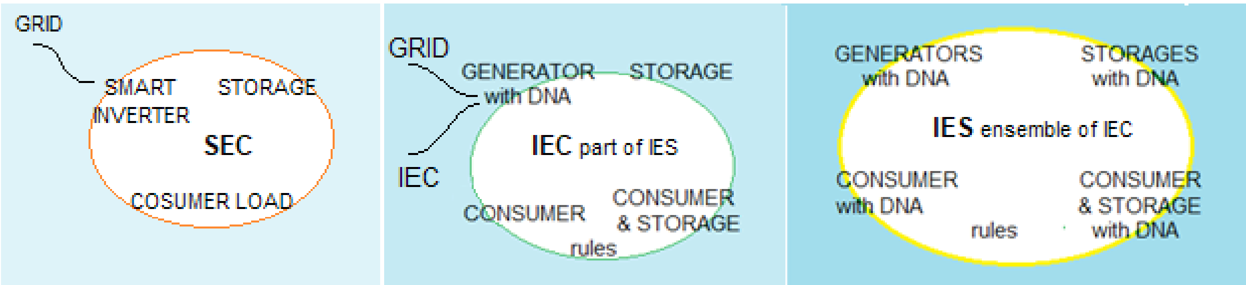

Figure 6.From smart energy cell to intelligent energy system as ensemble of intelligent energy cells

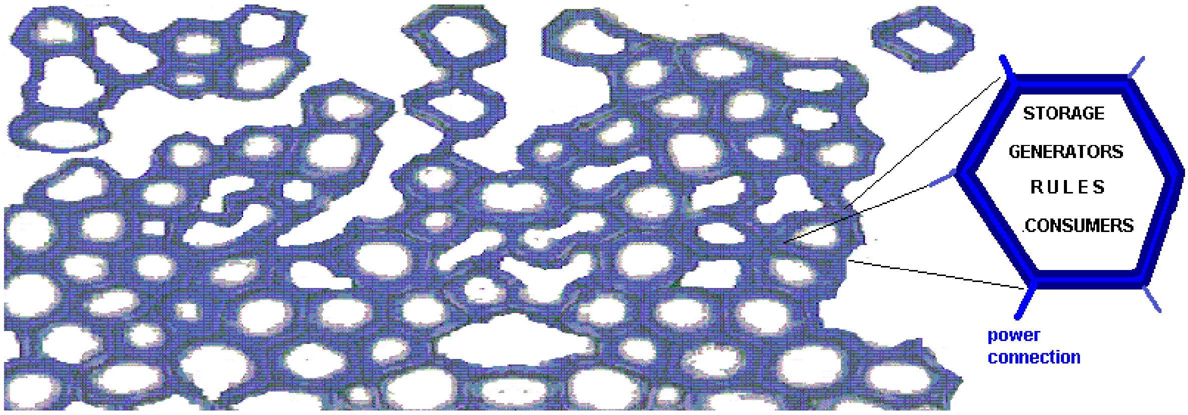

Figure 7.Tissue of cellular IEC, island IES and large IES [Căpățînă, 2013]

The future is an intelligent energy cell, IEC, as part of an intelligent energy systems, IES, where every component has its own DNA, that shape the behavior for assuring its goals. On the thinking table the researchers must find the near step between microgrid and IEC, as part of IES [Căpățînă, 2013]. And this near step is a renewable cell with storage anda smart inverter that serve its own load and could exchange energy with the public grid, the smart energy cell, SEC (fig.6, 7,9). The cell's load remains in cell'scharge during the peak of consumption and in the consumption pit the cell is borrowed from the public network; the daytime surplus of cell's energy is delivered to the network. All this energy management should be done by the cell via the smartinverter (fig 9). Because of solar"democratic"shines,most renewable cells should be photovoltaic.

The Size of Storages in The Small Photovoltaic Cell

The size of storages can not be too large because of two reasons: once the batteries are too expensive and second it doesn't resolve the problem of uncollected energy in the warm season. The uncollected energy is the energy

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that exceed the capacity of batteries every hour of the day, day after day.

On two photovoltaic cells, everyone with 1,8kWdc panels, but with two different storage capacities, first with 9kWh and the second with 36kWh (fig.8), after a simulation with KOSON application*, the uncollected energy in the warm season means 418KWh, in the first case, and, in the second case, 387kWh.Despite the 4-fold increase in storage capacity,the uncollected energy declined by only 31kWh, from 418kWh to 387kWh. Only 31kWh/year is the gained with an increased price from 2.22euro/watt to 4.09kWh/watt (fig.8). From 2700 to 5300euro of all over investment cost.The differencesresults as KOSON modelingon uncollected photovoltaic energies between the two cases, by months in the warm season, are presented in the table 1.

Table 1.The uncollected energy

The uncollected energy during warm season							
Cbat [kWh]	apr	may	jun	jul	aug	sep	Price** [euro]
9	49	73	83	97	93	23	3048
36	22	71	82	96	93	23	5614

Notes: * the KOSON application is a collection of programms, written in MATLAB, to simmulate the behavior of small renewable cells.
**wholesale prices

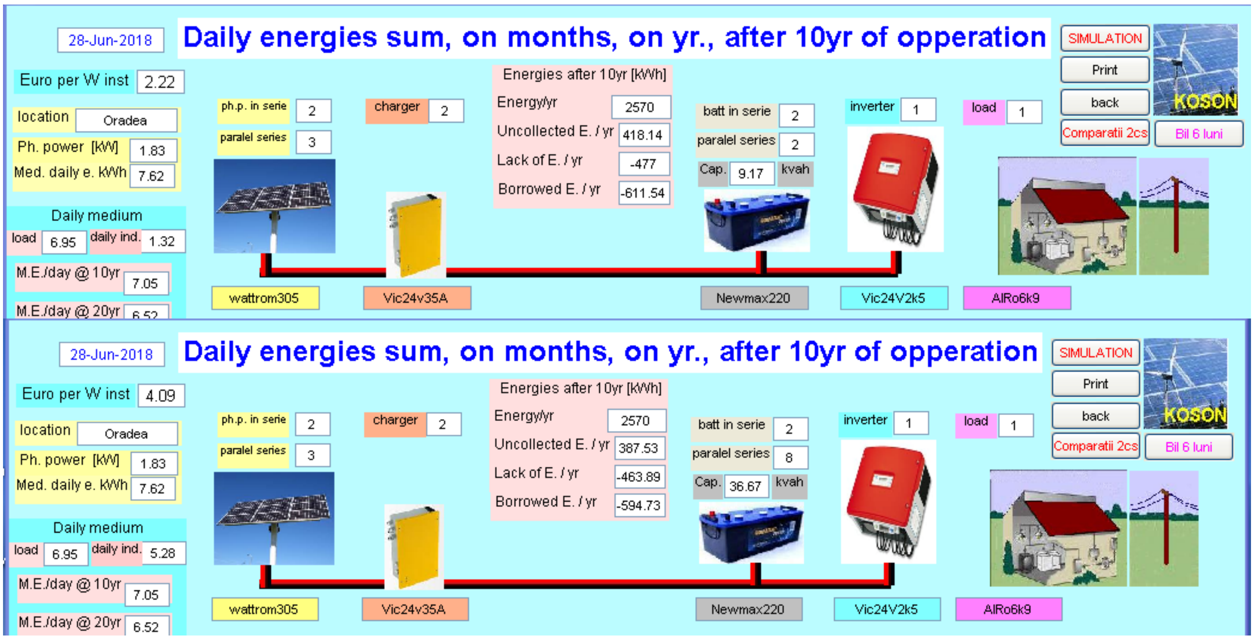
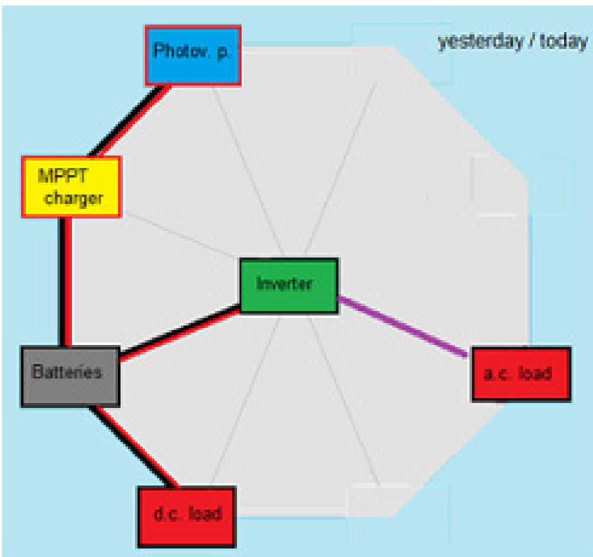


Figure 8.Two simmulation with the emphasis on uncollected energy, one cell with 9, 17kWh batteries and other with 36,67kWh batteries



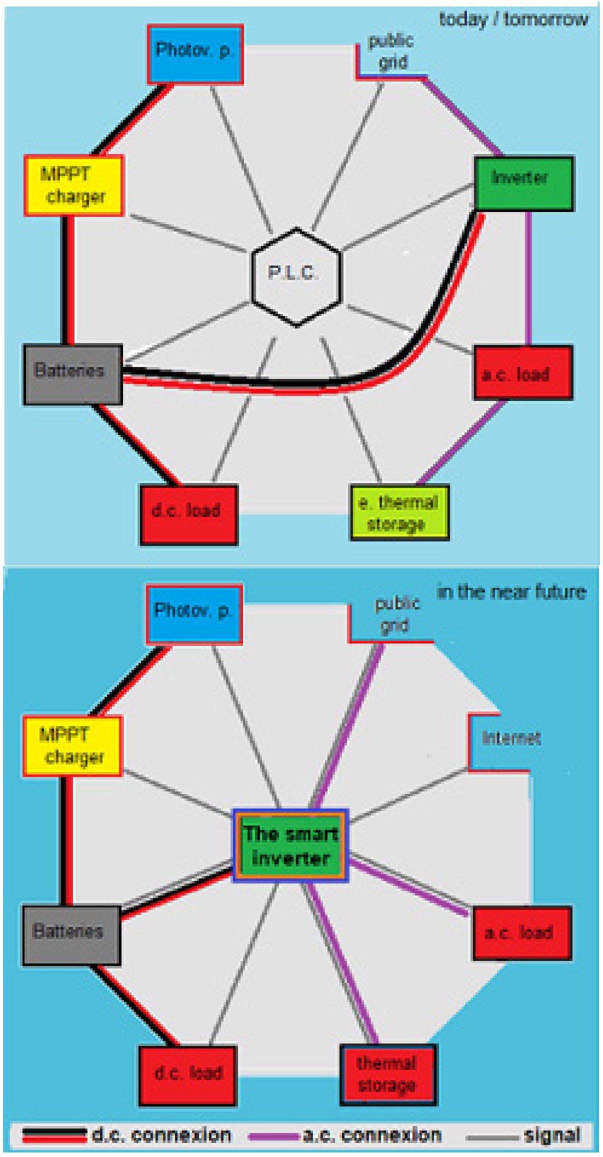


Figure 9.The first three steps toward IEC, through SEC

Conclusions

Today, almost all homes have electricity from the public grid. Tomorrow, most of these homes will produces its own energy from solar resources with small residential photovoltaic cells with batteries and connected to the public grid. These on/off grid photovoltaic cells,will manage all the flux of energies, included the exchange with the public grid. From SEC to IEC it is only a matter of understanding the future. We predict that in the future the machines, in general, would have its own DNA that help them to be more efficient, to be more suitable to complete its tasks.

Large widespreading of energy from solar resources will be facilitated by photovoltaic tiles and windows. Photovoltaic tiles and photovoltaic windows should be commons in the future as yesterday and today ceramic bricks.

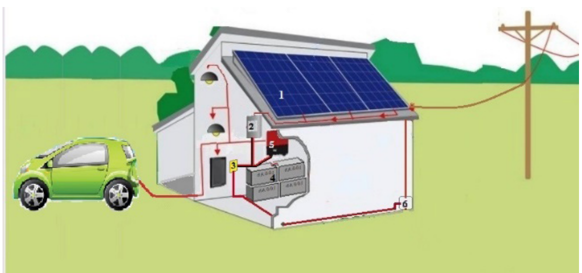


Figure 10.SEC, the today isolated renewable cell but with smart inverter and tied to the public grid

Figure 11.Transition from today to tomorrow roofs

Reference

1. Căpățînă. "One holistic vision of the future energy systems," IJEE, April 2013; 3(2).
2. Capațînă, Darie. "Steps towards to future in the power systems", ICNTET Conference, India. 2018.
3. Farrel. Small-Scale Solar a Better Deal than Big. 2018.
4. https://www.renewableenergyworld.com/ugc/articles/2018/03/19/solar-surprise-smallscale-solar-a-better-deal-than-big.html.
5. Căpățînă. Contribuții la integrarea pe scară largă a surselor fotovoltaice rezidențiale în SEN, UTCN, unpublised yet. 2018.
6. Ossila. https://www.ossila.com/pages/perovskites-and-perovskite-solar-cells-an-introduction. 2018.
7. REW. Renewable Enegy World, March 2018 issues.

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